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XXXIII.—*A Contribution to the Osteology of the Head of* Hatteria*. By Friedrich Siebenrock, Assistant in the Imperial and Royal Natural History Museum in Vienna.

[Plate XIV.]

The present memoir contains a precise description of the interorbital septum, the anterior cartilagino-membranous cranial wall, and of the paroccipital, which is present in *Hatteria* alone among Saurians.

In addition to this there follows a detailed account of the several cranial bones, especially with reference to the bony auditory structures contained within them. These are distinguished by the presence of the fossa cochlearis of the basi-occipital, the junction of the orificium ampullæ canalis semicircularis frontalis and the orificium canalis semicircularis horizontalis in the posterior ampullary chamber of the paroccipital, the absence of the foramen nervi acustici, ramus cochlearis, the absence of the foramen canalis Vidiani anterius in the fossa hypophyseos, and by the remarkable structure of the superior margins of the paroccipital and of the otosphenoid.

Finally, it will be shown that the parietal is paired even

* Translated from the 'Sitzungsberichten der kaiserl. Akademie der Wissenschaften in Wien, Mathem.-naturw. Classe,' Bd. cii. Abth. i., June 1893, pp. 250–268: from a separate impression, communicated by the Author.

in the adult, a point which was hitherto in doubt; while there will also be appended further communications upon the subject of the dentition of the vomer.

I.

The **interorbital septum** and the **anterior cranial wall** of *Hatteria* were represented by Günther* and Brühl† as homogeneous cartilaginous structures, without further allusion being made to them in the text of their papers. If, however, these parts be examined more closely in a carefully prepared *Hatteria*-head, it is found that neither the interorbital septum nor the anterior cranial wall are uniformly developed, but that in both cartilaginous structures occur, just as they are met with in the majority of Saurians with a distinct interorbital septum.

In the interorbital septum of *Hatteria* the anterior and upper edges are sinuous, while the lower one is straight. The posterior edge is notched and forms the anterior boundary of the optic foramen. In the majority of lizards the interorbital septum is membranous, and in it is embedded the cartilaginous plate which has developed from the two lower trabeculæ ("unteren Schädelbalken"). In *Hatteria*, however, the entire interorbital septum is cartilaginous, with the exception of an oval fenestra at the upper margin, which is covered by a membrane. But since the cartilaginous plate in the interorbital septum in the case of the other lizards represents the presphenoid, in *Hatteria* the entire interorbital septum must receive the same interpretation.

A much greater degree of complication is presented by the cartilaginous structures in the anterior cranial wall, with regard to which Günther writes (*loc. cit.* p. 5) :—"A crescentic space between alisphenoid and columella remains cartilaginous; and the fore part of the cranial cavity is closed by fibro-cartilaginous membrane without a trace of ossification." It is perfectly correct that a bony orbitosphenoid is not present in *Hatteria*, but in its stead we find a cartilaginous one, which exhibits the same arrangement as in all other lizards. It is remarked by Baur‡, in a note upon *Sphenodon—Hatteria*, that the alisphenoid-orbitosphenoid is

* A. Günther, "A Contribution to the Anatomy of *Hatteria*," Phil. Trans. Roy. Soc. Lond. 1867.

† C. B. Brühl, 'Zootomie aller Thierclassen,' Taf. 148 and 149, with explanation.

‡ G. Baur, "Osteologische Notizen über Reptilien (Fortsetzung vi.)." Zool. Anzeiger, xii. Jahrg., 1889, p. 45.

cartilaginous and is closely applied to the epipterygoid-columella, but no further details are given. The presence of an orbitosphenoid in *Hatteria* is likewise pointed out by Cope *, though it would follow from the author's statement that the structure in question is bony and not cartilaginous: for upon page 189 he writes that in the membranous cranial wall in lizards an ossification occurs, upon which he bestows the provisional designation "postoptic," and does not term it the alisphenoid, like Parker, since, according to his view, the epipterygoid-columella is the real alisphenoid. Coming to *Hatteria*, he then proceeds to say:—"In the Rhynchocephalian genus *Sphenodon* these two elements [*i. e.* the postoptic and epipterygoid] coexist with an orbitosphenoid, lying between the optic and trigeminal foramina. The two together may be homologous with the mammalian alisphenoid." I am not of this opinion, since the orbitosphenoid is in the case of *Hatteria* precisely as in that of the other lizards, if it occurs at all, without any connexion with the epipterygoid-columella, and remains in a cartilaginous state throughout life. It is semilunar in shape, and forms with the posterior notched edge of the presphenoid, with which it is united above and below, an oval hole, the optic foramen, for the exit of the optic nerve.

From the upper third of the posterior edge of the orbitosphenoid a stout cartilaginous process projects backwards and somewhat upwards, and then divides into two thinner rami. Of these the uppermost and shorter has an anterior and upward direction; it runs to the first postfrontal and unites with the upper trabecula. The lower and considerably longer ramus trends downwards and backwards, and runs almost parallel with the lower portion of the cartilaginous orbitosphenoid; it unites with the processus anterior inferior of the otosphenoid and with the processus alaris of the basisphenoid.

It follows from what has just been stated that the orbitosphenoid is not embedded in the anterior cranial wall in complete isolation, but is in intimate connexion with the bony sphenoid group and with the roofing bones of the head.

The anterior cranial wall, which is cartilaginous in *Hatteria*, is fixed to the crista cranii frontalis, and passes forwards in the shape of a narrower canal to the olfactory cavity; where, however, it expands once more in an aliform manner, since it reaches down on each side on the inner edge of the prefrontal as far as the anterior extremity of the palatine, and thus forms the optic-nasal septum. The groove itself

* E. Cope, "The Osteology of the Lacertilia" (reprinted May 10, 1892, from Proc. Amer. Phil. Soc. vol. xxx.).

serves for the reception of the olfactory nerves, and consists in *Hatteria* of tough cartilaginous tissue, while in the majority of lizards it merely remains in a membranous condition.

II.

The **bony cranium** consists, as in all lizards, of the occipital and sphenoid groups of bones. The latter [*sic*!—former?], again, is composed of the basioccipital, supraoccipital, and the two pleuroccipitals which lie between these. All four occipitals enclose the occipital foramen, an oval aperture with a greater vertical than transverse diameter, on the lower circumference of which the unusually large occipital condyle is developed as a semilunar tubercle. In *Hatteria* this is formed in a conspicuous degree from the basioccipital, while the two pleuroccipitals take a much smaller share in it, in contrary fashion therefore to what we find in the chamæleons, in which the partes condyloideæ of the pleuroccipitals are much larger than the pars condyloidea of the basioccipital. In adult individuals the four occipital elements are indistinguishably fused together, while in specimens which are still young they remain separated by sutures, precisely as in the case of the rest of the Lacertilia. Now in young specimens we find that the pleuroccipital is composed of two bones, which are separated one from another by a suture. The one bone with its pars condyloidea is connected in the shape of a semicircle with the basioccipital below, constitutes the lateral margin of the occipital foramen, and unites above with the supraoccipital. From the middle of its external circumference a short pointed process projects almost horizontally outwards. This bone is manifestly, according to position and function, the pleuroccipital—exoccipital of Owen and Huxley. Before this there lies a bone, which unites with the otosphenoid in front, with the supraoccipital above, and with the basioccipital below. Its posterior surface is convex and its anterior concave, with which it forms the posterior wall of the bony labyrinth. The processus paroticus projects outwards and backwards. I consider this bone as the paroccipital, exoccipital of Brühl, and opisthotic of English authors. Günther also describes (*loc. cit.*) a paroccipital, which, however, cannot be quite identical with that discovered by me. According to this author the paroccipital is superimposed upon the processus paroticus merely in order to strengthen it, without taking part in the formation of the auditory apparatus. Günther writes:—"It [namely the processus paroticus] is strengthened by a paroccipital, which covers nearly

the entire side of the process and is united with the occipital part by only partly distinct sutures." The paroccipital described by me forms the posterior wall of the labyrinth and sends the processus paroticus outwards. It is consequently a bone of considerable importance, separated by a suture from the pleuroccipital. Only on the posterior surface of the paroccipital does the suture between it and the pleuroccipital remain indistinct at a spot which is of quite small extent, so that here the two bones appear to be united by synostosis. It may be that the specimens which I examined were not sufficiently young in order to show the complete separation of the bones in question. I was able, nevertheless, in the crania of three individuals to perceive distinctly the suture between paroccipital and pleuroccipital, which separates the two bones one from another with the exception of a small space, so that the possibility of a merely individual separation of these two bones seems to be excluded.

I imagine that Günther probably identified the paroccipital correctly, but the sutures in the specimen investigated by him were no longer sufficiently distinct to enable him to recognize the precise limits of the bone in question. He says, moreover, in a note (*loc. cit.* p. 2):—"The sutures between these bones [namely between supraoccipital and exoccipital] are so indistinct that they could not be represented in the drawing." It is the more remarkable that Brühl (*loc. cit.*) did not perceive the division between the paroccipital and pleuroccipital, since nevertheless he figures and describes the head of a young individual in which all the sutures between the several bones of the occipital and sphenoid groups were still distinctly visible. He assumes an attitude of vigorous opposition to Günther's alleged paroccipital:—"The pleuroccipital . . . . . is, as I must maintain in opposition to an absolutely incorrect statement on the part of Günther (*loc. cit.* p. 596), the only lateral element of the occipital segment in *Hatteria*; no other element, no exoccipital [*mihi*, paroc., *Owen*, opisth. of English authors] exists at all. Günther's statement that a paroccipital of Owen [exoccipital, *mihi*] is to be found in *Hatteria* is based upon an extremely superficial inspection, erroneously conducted upon entire preparations (!), which, however, was not supported by any more precise investigation (disarticulation! the only anatomical method which is here conclusive)." As is evident from my description, Brühl was entirely in the wrong in disputing Günther's statement; the paroccipital is present in young individuals, so that consequently *Hatteria*, like the Chelonians, exhibits six occipital elements, namely:—1 basioccipital, 1 supraoccipital,

2 pleuroccipitals, and 2 paroccipitals. On account of this remarkable fact *Hatteria* approaches the Chelonians and recedes further from the Lacertilians.

It may not be without interest to give a separate representation and description of the individual bones of the cranium of *Hatteria*, specially with a view to the acquisition of a more precise knowledge of the bony auditory structures contained within them. Günther (*loc. cit.*) did not figure the cranium or its individual bones, and Brühl, although he gave a representation of the cranium from below and behind, paid less attention to the auditory apparatus than to the demonstration of the absence of a paroccipital as alleged to exist by Günther.

The **basioccipital** is an almost quadrangular and somewhat bulky bone. Its upper surface is concave, while its under convex surface is swollen at the two lateral margins and with the basisphenoid forms the two very powerfully developed tubercula sphenooccipitalia. These are always characterized by an epiphysis.

Behind the tubercula sphenooccipitalia lies the very large pars condyloidea, which forms the posterior border of the basioccipital, at the two angles of which are situated the points of attachment for the pleuroccipitals. The anterior border is almost straight; it serves to unite the bone with the basisphenoid, which, with its two posterior processes, which are separated by a triangular notch, lies upon the under surface of the basioccipital and reaches to the tubercula sphenooccipitalia. In this manner there arises in relief upon the under surface of the basioccipital a triangular protuberance. The two lateral borders of the basioccipital unite posteriorly at the pars condyloidea with the pleuroccipitals, in the middle and anteriorly with the paroccipital and the otosphenoid. Each lateral border of the basioccipital exhibits indeed in front of the pars condyloidea a somewhat deep indentation, the incisura venæ jugularis, which, with a similar indentation constituted by the paroccipital and pleuroccipital, is completed to form the foramen jugulare. In front of this incisura venæ jugularis the lateral border towards the anterior angle is transformed into a deep pit, the posterior margin of which unites with the paroccipital and the anterior with the basisphenoid, while its outer and inner margins serve to support the membranes which fill up the space between the three bones already mentioned and the otosphenoid. This pit closes the bony cochlea below. It was shown by me that it also occurs in *Brookesia superciliaris**, where I designated it the fossa cochlearis. It has an oblique situation in a

* F. Siebenrock, "Das Skelet von *Brookesia superciliaris*, Kuhl,"

direction from outside inwards, and to its lower circumference is attached the tuberculum sphenooccipitale.

The **pleuroccipital**, which in young individuals is separated by a suture from the paroccipital, constitutes a simple bony arch. Its lower end is swollen to form the pars condyloidea, while the upper shovel-shaped end runs out into two pointed processes; by means of these it is attached to the hinder surface of the paroccipital and to the supraoccipital. The inner margin of the arch forms the lateral boundary of the occipital foramen, from which the paroccipital is entirely excluded. The external margin of the arch, which is much shorter than the internal one, forms the upper and posterior limit of the foramen jugulare, and contains from above downwards the foramen nervi hypoglossi, the foramen nervi vagi, and the foramen nervi glossopharyngei. The last two nerve-exits are frequently united into one externally, but internally they always remain separate.

In the representation of the occipital region of a young *Hatteria* Fritsch * has figured the pleuroccipitals alone as the lateral limiting bones of the foramen occipitale, but he adds no explanation as to whether in his specimen the pleuroccipitals were separated from the paroccipitals, or whether he had omitted the latter merely for the sake of simplifying the figure. Otherwise the outlines of the pleuroccipitals as reproduced by this author are perfectly true to nature.

The **supraoccipital** is an unusually broad bony arch, which extends from the occipital foramen as far as the anterior end of the processus anterior superior of the otosphenoid. Upon the upper curved surface there arises in a sagittal direction a low crest, the crista occipitalis, which produces the immovable connexion with the parietal. Underneath the supraoccipital constitutes a sagittal groove, which at its hinder end is contracted by the inner walls of the vestibular portion and at the lower margin of which in front lies the orificium externum of the aqueductus vestibuli. The posterior border has a semicircular excavation and forms the upper boundary of the occipital foramen. The two posterior and obliquely truncated angles are expanded in the shape of hollows, and constitute on each side the roof of the vestibular chamber; they unite with the pleuroccipital and paroccipital. The lateral borders come into contact with the otosphenoids, while the free anterior margin exhibits three projections, produced by two indenta-

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Sitzgsber. k. Akad. Wiss. Wien, Math.-naturw. Classe, Bd. cii. Abth. i., 1893, p. 76.

* Dr. A. Fritsch, "Fauna der Gaskohle und der Kalksteine der Permformation Böhmens," Bd. 2, Prag, 1889, p. 58.

tions. On the inner wall of the roof of the vestibular portion lies the inosculation of the commissure of the canalis semicircularis frontalis and the canalis semicircularis sagittalis, and in front of this at the lower margin of the inner wall the orificium internum of the aqueductus vestibuli. At the upper external margin of the vestibular portion the foramen canalis semicircularis frontalis is visible, while the foramen canalis semicircularis sagittalis lies away towards the middle of the lateral border of the supraoccipital at a distance from the vestibular portion. This aperture is otherwise usually found in lizards at the anterior circumference of the vestibular portion. On the upper surface of the supraoccipital neither canal is noticeably visible; the sagittal canal stands out on the inner surface pretty distinctly.

The **paroccipital**, which in young individuals constitutes an independent bone, has some similarity to a spoon, for it is strongly arched and sends off outwards a long process, the processus paroticus. The paroccipital forms the posterior wall of the bony labyrinth, and unites with the otosphenoid in front, with the supraoccipital above, and with the basioccipital below. To the posterior wall is attached the upper end of the pleuroccipital, while the lower end of this, which as pars condyloidea unites with the basioccipital, forms with the posterior wall of the paroccipital the incisura venæ jugularis and is completed with the basioccipital to form the foramen jugulare. From the anterior external border, which is excavated in the shape of a semicircle and forms the incisura foraminis vestibuli, arises the processus paroticus. This is long, strongly compressed, hollowed out in the shape of a groove in front for the accommodation of the columella auris, and directed horizontally and somewhat backwards. The anterior excavated surface of the paroccipital forms the hinder portion of the vestibulum. It is divided into the outer portion, which extends in the shape of a crescent from above downwards, and the inner, smaller, but very deep portion, the posterior ampullary chamber, which forms an oval pit and at the bottom contains two holes, the orificium ampullæ canalis semicircularis frontalis above and more towards the rear, and the orificium canalis semicircularis horizontalis below and more towards the front. The vestibulum in *Hatteria* consequently possesses one hole less than in the majority of lizards, in which the two orifices just mentioned, divided by a septum, open into the vestibulum, while in *Hatteria* they fuse together into one large oval hole. At the upper margin of the vestibular cavity, to which the supraoccipital is attached behind and the otosphenoid in front, we find posteriorly the foramen

canalis semicircularis frontalis and anteriorly the foramen canalis semicircularis horizontalis.

These two foramina are connected together by a cleft or fissura (Pl. XIV. fig. 5, *x*), which divides the upper margin longitudinally into an upper and lower half. The cleft at this spot has arisen through the approximation of the outer and inner lamellæ of the vestibular wall. In addition to this the long transverse cleft in front of the foramen canalis semicircularis frontalis is also connected by a short cleft, running at right angles to it, with the oval pit, the inosculation of the orificium ampullæ canalis semicircularis frontalis and the orificium canalis semicircularis horizontalis. In no other living lizard is this remarkable phenomenon to be observed. The lower border of the paroccipital exhibits externally an aliform prolongation, and appears, with its lower portion at least, to form the posterior wall of the cochlea, which is bounded below by the very strongly developed fossa cochlearis of the basioccipital, while externally it is enclosed by the cartilaginous plate which extends between the paroccipital, otosphenoid, and basioccipital.

The **basisphenoid** consists of the body, which constitutes a trapeziform plate of bone, and of the two alary processes. The upper concave surface exhibits a median division into two halves by means of a sagittal furrow. This was previously remarked by Baur, who expressed the conjecture (*loc. cit.*) that the basisphenoid arises from two lateral halves. On both sides of this furrow in the anterior third lie two foramina, the orifices of two short canals for branches of the internal carotid. The straight posterior border of the basisphenoid unites with the anterior border of the basioccipital. Beneath it there project backwards two triangular processes, which attach themselves to the under surface of the basioccipital and with their ends help to form the tubercula sphenooccipitalia. The anterior border, which as dorsum ephippii overhangs the fossa hypophyseos, is deeply indented, so that its two angles become transformed into the processus alares. The two lateral borders converge towards the front and serve to connect the bone with the otosphenoids.

From the anterior portion of the under surface of the basisphenoid arise the processus pterygoidei. They are moderately long, inclined somewhat forwards, and diverging at the ends, on the outer sides of which lie the articular surfaces for connexion with the pterygoids.

Between the processus pterygoidei arise the fairly long cylindrical processes for the inferior trabeculæ; they are separated by a furrow, which ends posteriorly in the shape of

a pit. In the latter lies on both sides the foramen caroticum internum. The cylindrical processes form the floor of the fossa hypophyseos, in the roof of which on each side, consequently at the base of the processus alares, is situated the foramen for a branch of the internal carotid, which opens into the cranial cavity on the upper surface of the basisphenoid by the hole already mentioned. On the under surface of the basisphenoid between the processus pterygoidei arises the parasphenoid; this extends forwards below the cylindrical processes as a narrow dagger-like bone. Its free portion is somewhat longer than the body of the basisphenoid. Fritsch (*loc. cit.*) and Baur (*loc. cit.*) have expressed the conjecture that the parasphenoid, forming the entire under portion of the basisphenoid together with the processes which project backwards, in very young individuals admits of being separated from the basisphenoid as an independent bone, I thoroughly concur in this view, since on the underside of the basisphenoid it is possible to trace almost the entire outline of the parasphenoid; only, in my opinion, Fritsch is mistaken in believing that the processes for attachment to the pterygoids also belong to the parasphenoid. It has been shown by Parker* that the basisphenoid is formed by the union of three ossifications, the lateral ones of which are the processus pterygoidei. Moreover the parasphenoidal plate is separated from the base of the processus pterygoideus by a cleft, so that as a matter of fact no connexion exists between the bony parts in question. In this cleft lies the posterior foramen caroticum internum.

In the lizards we find in the fossa hypophyseos three pairs of apertures: in front on both sides of the cylindrical processes the foramen canalis Vidiani anterius, behind at the bottom of the fossa the foramen caroticum internum, and at the side and above the foramen for a branch of the internal carotid. *Hatteria*, however, like the Chelonians, possesses only two pairs of apertures in the fossa hypophyseos, since the foramen canalis Vidiani anterius is absent. Here we have a further character in which *Hatteria* recedes from the lizards and approaches the Chelonians in the structure of the head.

The **otosphenoid** is a quadrangular bone, the upper angles and the inferior anterior angle of which are produced into processes, while the inferior posterior angle remains blunt. The upper border unites with the supraoccipital; its posterior end is produced into a moderately long, triangular, pointed process, the processus posterior, which is applied like a scale

* W. K. Parker and G. J. Bettany, 'The Morphology of the Skull' (London, 1877): German translation by B. Vetter, 1879.

to the anterior surface of the processus paroticus, and forms the upper margin of the sulcus columellæ auditus.

The anterior end of the upper border is likewise produced into a process, the processus anterior superior, which in the other lizards remains very short and serves for the attachment of the upper trabecula.

The lower border unites with the basisphenoid; its anterior end is elongated in the shape of a shovel and forms the processus anterior inferior, which is united with the processus alaris of the basisphenoid. The anterior end of the bone serves for the attachment of the lower cartilaginous branch of the orbitosphenoid. The posterior truncated end of the lower border unites with the plate of cartilage which extends between the otosphenoid, basisphenoid, paroccipital, and basioccipital. The posterior free border of the otosphenoid, together with the paroccipital, encloses the very large foramen vestibuli seu ovale. On the anterior free border we find a crest which is quite small, indicating the ala otosphenoidea, below which is situated the incisura otosphenoidea for the exit of the fifth nerve (trigeminus).

The external surface of the otosphenoid is strongly convex. Upon it may be seen standing out in relief in front and above the canalis semicircularis sagittalis running towards the middle, and the canalis semicircularis horizontalis running in the same direction from the base of the processus posterior superior. Towards the lower border, behind the origin of the processus anterior inferior, we find an indication of a very short crista otosphenoidea, behind which lies the foramen nervis facialis.

The inner surface forms the anterior vestibular cavity, and for this purpose is strongly excavated. It consists of the posterior portion, the actual vestibulum, and of the anterior, much smaller, but very deep portion, the anterior ampullary cavity. Into this there opens quite at the bottom, as a transversely oval hole, the orificium ampullæ canalis semicircularis sagittalis, the orificium ampullæ canalis semicircularis horizontalis above, and below, the oval foramen nervi acustici. A distinct crista cochlearis separates the vestibulum from the semicanalis seu canalis lymphaticus which lies below it, and which does not run horizontally as in the other lizards, but obliquely downwards and backwards from in front and above. This forms the upper portion of the cochlea, the outer and inner walls of which are constituted by the two plates of cartilage, which fill up externally and internally the gaps between the occipital and sphenoid bones, as we find is similarly the case in the Chelonians. Of the foramen nervi

acustici for the ramus cochlearis, which in the other lizards leads into the cochlea, we find no trace whatever in *Hatteria*. On the upper border of the otosphenoid are situated two holes, the foramen canalis semicircularis sagittalis in front and the foramen canalis semicircularis horizontalis behind at the base of the processus posterior. In this case the two holes themselves are not connected by a cleft, as we find them to be in the paroccipital, but each hole (Pl. XIV. fig. 10, x' and x'') is in connexion with the anterior ampullary cavity, so that it looks as if the holes and their canals have arisen as a result of the laying together piece by piece of the walls of the vestibulum, a condition which is seen in *Hatteria* alone, as was pointed out above in the case of the paroccipital.

On the inside of the otosphenoid, behind the incisura otosphenoidea and in front of the anterior vestibular wall, lies an oval pit, which contains the foramen nervi acustici above and the much smaller foramen nervi facialis below.

I have observed in many lizard skulls that the basioccipital remains longest separate from the rest of the occipital bones.

In *Hatteria* the converse appears to be the case, for here the basioccipital is always already united by synostosis with the two pleuroccipitals, when the remaining bones are still distinctly divided by sutures.

In the case of the sphenoid bones at first merely the processus anterior inferior of the otosphenoid coalesces with the processus alaris of the basisphenoid, while the two bones behind the crista otosphenoidea still continue separated by a distinct suture.

III.

The parietal of *Hatteria* is described by Günther (*loc. cit.* p. 2) as follows:—"The parietal bone is very narrow and elevated into a strong mesial crest, which, although appearing simple in an individual of advanced age, evidently consisted of two lateral halves in youth," &c. In opposition to this Brühl writes (*loc. cit.*):—"The parietal, which even in younger skulls already appears unpaired, although it may well be paired in the embryo," &c. Five *Hatteria* skulls disarticulated by me have yielded the result that the parietal remains paired not merely in youth, but throughout life. In the case of a skull, too, in which all the sutures of the bony cranium had already completely disappeared, a proof that the specimen was certainly already adult, the parietal fell of itself into two halves after careful maceration. These are united in *Hatteria* by synchondrosis, and not, as in the Asca-

labota, by a simple suture. The inner surfaces, which are elevated into the paired crest, are very broad, but perfectly flat, and are firmly united together by the cartilaginous tissue which is embedded between them. The large parietal foramen, which is always of an oval shape, is in all the nine *Hatteria* skulls which I have examined formed by the two halves of the parietal alone, and the frontals contribute in not the slightest degree to its limitation. The processus parietales are fairly long, it is true, but do not reach the processus paroticus of the parietal any more than in the case of the majority of lizards, but attach themselves to the outer and inner surface of the superior posterior process of the supratemporal. Each processus parietalis is indeed divided into a longer posterior and a shorter anterior lamina, between which the lower border of the posterior superior process of the supratemporal is wedged in.

IV.

The Vomer.—Baur* was the first to announce the interesting fact that he had found in a young *Hatteria* a distinctly developed tooth in the centre of each half of the vomer. A communication was subsequently published by Howes† as to further cases of the dentition of the vomer in *Hatteria*. Out of nine specimens he found that the vomer was toothed in four cases, while five were toothless. Of the former, three possessed a tooth on each half of the vomer, while in the case of the fourth specimen a tooth was developed upon the right half of the vomer alone. These teeth, however, had not broken through the mucous membrane of the palate, as Howes was able to convince himself in the case of two individuals, but their tips were covered by it, so that they were not visible in the cavity of the mouth:—"its apex was exposed, but it could not in any sense be said to project into the cavity of the mouth." And with regard to the second example he writes:—"In the other specimen the insignificant vestiges of the teeth, which were present, lay wholly beneath the mucous membrane, which completely covered their apices."

Among the nine *Hatteria* skulls examined by me I found teeth upon the vomer in only one, while the remaining eight exhibit no trace of such a dentition. In the toothed specimen the right half of the vomer possesses two teeth, the left, on

* G. Baur, "Osteologische Notizen über Reptilien, I. Rhynchocephalia," Zool. Anzeiger, ix. Jahrg., 1886, p. 685.

† G. B. Howes, Proc. Zool. Soc. Lond. 1890, part iii. p. 358.

the contrary, only one tooth, but the spot where a second was situated can still be distinctly seen. The teeth are fairly long, with conical points, covered with enamel, and with the tips of a dark colour and curved inwards. The dark colour of their tips, apart from the considerable length of the teeth themselves, allows us to conclude that they had broken through the mucous membrane of the palate and projected into the cavity of the mouth.

It is certainly very remarkable that relatively few specimens possess the vomerine teeth. Baur (*loc. cit.*) has expressed the conjecture that they only exist in young specimens and disappear in old age. Howes, however, has observed the vomerine teeth in an old specimen—"in a senile old male"—and, further, found that all the four individuals which possessed these teeth were demonstrably males. This last observation appears not to be without interest, and there is perhaps more probability in the idea that only the males possess the vomerine teeth than in Baur's conjecture that they are only present during youth. In two of the specimens which I examined I found no trace of teeth upon the vomer, although, to judge by their size and the separation of all their cranial bones, they were still fairly young, while another, adult, individual possessed the vomerine teeth in the manner already stated. Unfortunately I was unable to determine the sex of this specimen, since the internal organs were missing.

EXPLANATION OF PLATE XIV.

Fig. 1. Vomer from below.
Fig. 2. Interorbital septum and anterior cranial wall.
Fig. 3. Bony cranium from behind, with the omission of the right paroccipital.
Fig. 4. Supraoccipital from below.
Fig. 5. Right paroccipital from in front and within.
Fig. 6. Basisphenoid from in front.
Fig. 7. Basisphenoid from above.
Fig. 8. Basisphenoid from below.
Fig. 9. Basioccipital from above.
Fig. 10. Otosphenoid from the inside.
Fig. 11. Parietals from above.

Explanation of the Letters.

a.o. Ala otosphenoidea.
a.v. Aquæductus vestibuli.
b.o. Basioccipital.
b.s. Basisphenoid.
c. Columella.
cms. Commissure.
c.o. Canalis olfactorius.
c.oc. Condylus occipitalis.
c.s.o. Crista supraoccipitalis.
d.d. Dentes dextri.
d.e. Dorsum ephippii.
d.s. Dens sinister.
f. Frontal.
f.c. Fossa cochlearis.

f.ca. Foramen caroticum internum.
f.ca'. Foramen for a branch of the internal carotid.
fe. Fenestra.
f.hy. Fossa hypophyseos.
f.j. Foramen jugulare internum.
f.l. Foramen lacrymale.
f.oc. Foramen occipitale.
fo.f. Foramen canalis semicircularis frontalis.
fo.h. Foramen canalis semicircularis horizontalis.
fo.s. Foramen canalis semicircularis sagittalis.
f.p. Foramen parietale.
h.a. Posterior ampullary chamber.
i.j. Incisura venæ jugularis.
i.ot. Incisura otosphenoidea.
i.v Incisura foraminis vestibuli.
j. Jugal.
m. Maxilla.
n. Nasal.
o.a.s. Orificium ampullæ canalis semicircularis sagittalis.
o.c.h. Orificium canalis semicircularis horizontalis.
or.s. Orbitosphenoid.
o.s. Otosphenoid.
p. Parietal.
p.a.j. Processus anterior inferior.
p.al. Processus alaris.
pa.o. Paroccipital.
pa.s. Parasphenoid.
p.a.s. Processus anterior superior.
p.c. Pars condyloidea.
p.f. 1. First postfrontal.
p.f. 2. Second postfrontal.
p.m. Premaxilla.
p.o. Pleuroccipital.
p.p. Processus paroticus.
p.p.s. Processus posterior superior.
p.pt. Processus pterygoideus.
pr.f. Prefrontal.
pr.p. Processus parietalis.
pr.s. Presphenoid.
r.a. Ramus ascendens.
r.d. Ramus descendens.
s.c.a. Sulcus columellæ auditus.
s.l. Semicanalis lymphaticus.
s.o. Supraoccipital.
u.c. Inferior cylindrical processes.
v. Vestibulum.
v.a. Anterior ampullary cavity.
x. Cleft between *fo.f.* and *fo.h.*
x'. Cleft between *fo.s.* and *v.a.*
x''. Cleft between *fo.h.* and *r.a.*
II. Foramen opticum.
VII. Foramen nervi facialis.
VIII. Foramen nervi acustici.

XXXIV.—*On the* Elateridæ *of Japan.*

By G. Lewis, F.L.S.

[Continued from p. 266.]

Agriotes longicollis, sp. n.

Infuscatus, subopacus, fulvo-pubescens; elytris brunneo-testaceis, interstitiis planis, rugosis, striis tenuiter impressis; antennis pedibusque infuscatis.
L. 13 mill.

Elongate, dusky brown, somewhat opaque, with tawny pubescence; the head closely, rather coarsely and roughly punctate, frontal carina oblique laterally and well elevated; the thorax closely and evenly punctate, elongate, rounded off anteriorly, sides parallel in the middle, widening out a little before the posterior angles, angles rather acute; the scutellum obscurely punctulate, little pointed behind; the elytra testa-